

ARCTOSA STIGMOSA AND A. SUBAMYLACEA ARE TWO DIFFERENT SPECIES (ARANEAE, LYCOSIDAE)

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ABSTRACT. The Asian wolf spider *Arctosa subamylacea* (Bösenberg & Strand 1906), originally described from Japan, is currently treated as a junior synonym of the European *Arctosa stigmosa* (Thorell 1875). However, both species differ noticeably in genital and somatic morphology. Here, we remove *A. subamylacea* from its synonymy with *A. stigmosa* and redescribe both species from material recently collected in Asia and Europe. Both species differ in their habitat preferences, as *A. stigmosa* typically inhabits gravel and sandy habitats in alluvial river floodplains, whereas *A. subamylacea* lives in low vegetation near hills and in agricultural areas, sometimes near ponds and lakesides.

Keywords: Lycosinae, synonymy, morphological character, tegular apophysis

Wolf spiders (family Lycosidae Sundevall 1833) are distributed worldwide and represent a very diverse family of typically ground living spiders. Wolf spiders are easily recognized by their distinct eye arrangement, a notched trochanter and their mobile brood care (Dondale & Redner 1990), however the systematics and taxonomy of the group below the family level are still far from settled (Murphy et al. 2006). The genus *Arctosa* C.L. Koch 1848 represents a particularly puzzling systematic example. Recent molecular data could not confirm the traditional assumption that *Arctosa* is representative of the subfamily Lycosinae (e.g., Dondale 1986), and the genus may represent a new subfamily altogether (Murphy et al. 2006; see also Zehethofer & Sturmbauer 1998; Vink et al. 2002). The limitation of *Arctosa* itself has caused considerable controversy for quite some time (e.g., Braun 1963; Olinger et al. 2002) and, in particular, in relation

to Asian species, recent molecular data suggests that *Arctosa* does not represent a monophyletic taxon (Murphy et al. 2006; Park et al. 2007).

Arctosa subamylacea (Bösenberg & Strand 1906) was initially described from Japan and later regarded as a senior synonym of *Arctosa cervina* Schenkel 1936, originally described from China (Paik 1994). Earlier Zhang (1987) synonymized *A. cervina* with the European *A. stigmosa* (Thorell 1875) resulting in the current synonymy of *A. subamylacea* and *A. stigmosa* (Platnick 2007). However, the synonymy of both species has always been in dispute (Marusik et al. 2000; T. Kronestedt and H. Tanaka pers. comm.).

To elucidate the separate identities of *A. subamylacea* and *A. stigmosa* we examined representatives from across the known range of the taxa in Europe and Asia, including specimens from near the type localities of both species, i.e., Ukraine in the case of *A. stigmosa*, and Japan in the case of *A. subamylacea*. Despite close similarities the detailed comparison of somatic and genitalic

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characters revealed distinct and constant differences between specimens from Europe and Asia that warrant a refutation of Zhang's (1987) synonymy and a consideration of *A. stigmosa* and *A. subamylacea* as distinct species.

METHODS

We examined specimens collected in the countries from which both species were originally described, i.e., Ukraine (*A. stigmosa*) and Japan (*A. subamylacea*) and additional spiders from their putative ranges. Species descriptions are based on specimens preserved and examined in 75% alcohol under an Olympus SZH10 stereomicroscope. For scanning electron microscope photography with a Leo 1420VP scanning electron microscope (Carl Zeiss, Oberhofen/Germany), a dissected right pedipalp of *A. subamylacea* (lodged at NIAST) was fixed with Karnovsky's fixative and osmic acid, and sputter coated with gold. Morphological nomenclature follows Framenau & Yoo (2006). All measurements are in millimeters (mm) and are based on adult spiders.

Abbreviations.—Measurements (in mm): total length (TL), carapace length (CL) and width (CW), abdomen length (AL) and width (AW). Eyes: anterior row of eyes (AER), anterior median (AME), anterior lateral (ALE), posterior row of eyes (PER), posterior median (PME), posterior lateral (PLE). QPE = quadrangle of posterior eyes. Collections: ASJ = Arachnological Society of Japan, Otemon Gakuin University, Osaka, Japan; IKAS = Institute of the Korean Arachnological Society, Namyangju-si, Korea; NIAST = National Institute of Agricultural and Technology, RDA, Suwon-si, Korea; SMF = Senckenberg Museum, Frankfurt, Germany; SMNH = Swedish Museum of Natural History, Stockholm, Sweden; WAM = Western Australian Museum, Perth, Australia; ZMB = Museum für Naturkunde, Zentralinstitut der Humboldt-Universität, Berlin, Germany; ZMH = Zoologisches Institut und Zoologisches Museum, Universität Hamburg, Germany.

TAXONOMY

Lycosidae Sundevall 1833

Arctosa C.L. Koch 1847

Type species.—*Aranea cinerea* Fabricius 1777, by subsequent designation of Simon (1937).

Diagnosis (after Dondale & Redner 1983 and Paik 1994).—Medium to large spiders (5–16 mm). Carapace broad, rather low, and approximately even in height between median furrow and posterior eye row; coloration grayish-brown to black or mottled with gray or brown without properly defined longitudinal light bands. Chelicerae with two or three promarginal teeth and three retromarginal teeth. Abdomen usually pale and mottled, similar in color to carapace. Tegular apophysis of male pedipalp prominent, sclerotized, elongate, grooved or excavated on distal surface. Terminal apophysis conspicuous, in two parts or in one part, sometimes in different degrees of sclerotization. Embolus straight or curved. Epigynum of female usually with conspicuous atrium divided by median septum, no anterior hoods.

Arctosa stigmosa (Thorell 1875)

Figs. 1–5, 11, 12

Trochosa stigmosa Thorell 1875a:107–108; Thorell 1875b:175–176; Chyzer & Kulczyński 1891:74, pl. 3, fig. 13.

Lycosa stigmosa (Thorell): Simon 1876:280.

Lycosa vigilans L. Koch 1881:69–71, fig. 13 (synonymy established in Dahl 1908).

Arctosa stigmosa (Thorell): Dahl 1908:308, 321, fig. 38; Lugetti & Tongiorgi 1966:139–141, fig. II (1–4); Fuhn & Niculescu-Burlacu 1971:187–189, figs. 92a–e; Miller 1971:165, pl. 25, fig. 29, pl. 36, fig. 2; Loksa 1972:55, fig. 49C–D; Heimer & Nentwig 1991:320, fig. 855; Aakra 2000:157, figs. 3A–B, 4.

Arctosa turbida Rosca 1935: 252–254, figs. 11–12 (synonymy established in Fuhn & Niculescu-Burlacu 1971).

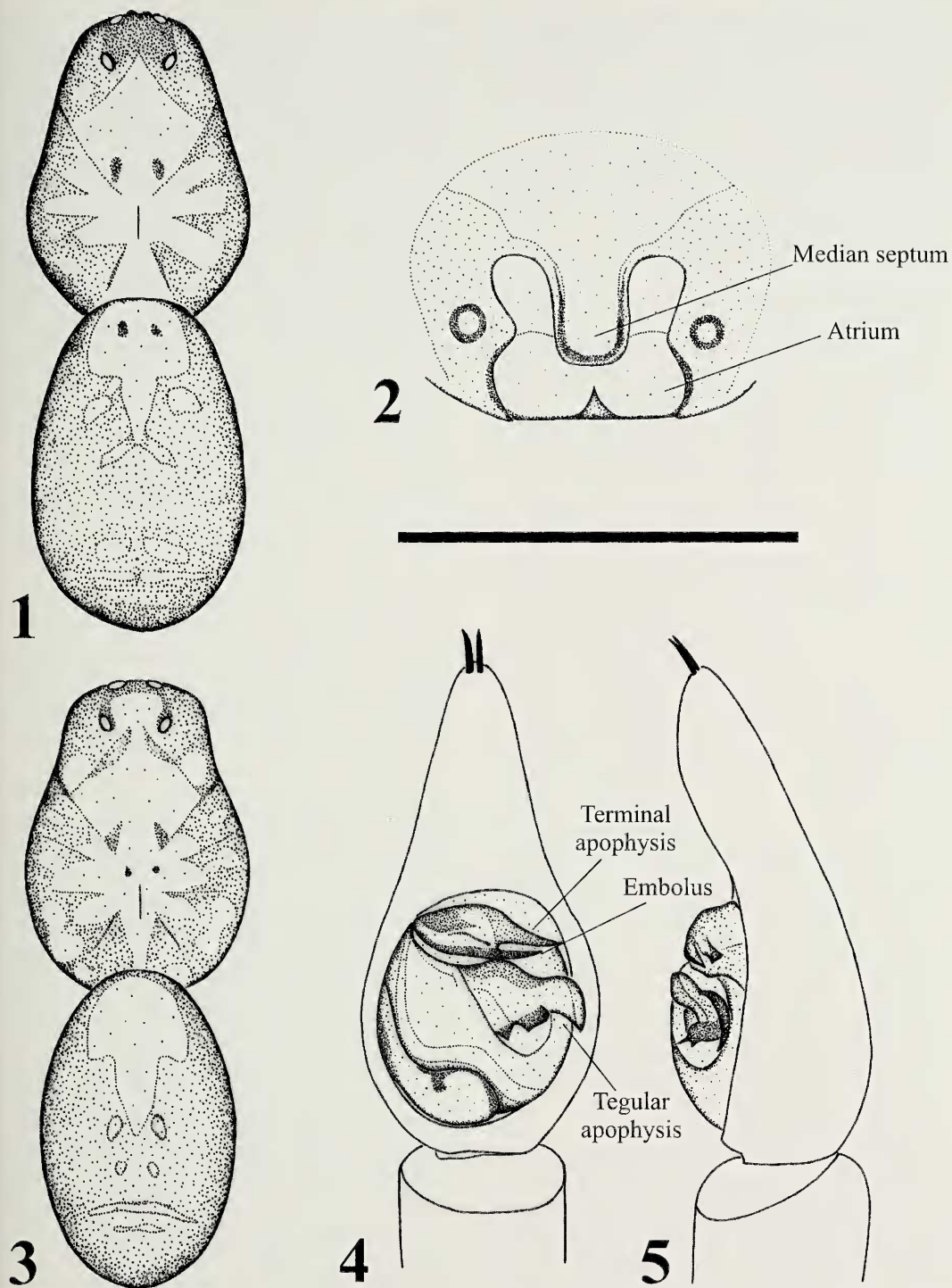
Lycosa turbida (Rosca): Roewer 1955:270.

Cynosa stigmosa (Thorell): Roewer 1955:239.

Type specimens.—*Trochosa stigmosa*: holotype female, UKRAINE: *Dnipropetrovsk Oblast*: Dnipropetrovsk (ca. 48°28'N 35°00'E), Al. v. Nordmann (Thorell 1875a) [depository unknown. The specimen is not present in SMNH or Zoological Museum of the University, Helsinki where Thorell's (1875a) types are expected to be housed, T. Kronstedt pers. comm.].

Lycosa vigilans: holotype female, GERMANY: *Saxonia*: near Niesky (ca. 51°17'N 14°49'E) [depository unknown; seen by Dahl 1908; not in ZMB (Moritz 1992) or ZMH (Rack 1961)].

Arctosa turbida: unknown number of syntype males and females, ROMANIA: *Sereth*:



Figures 1–5.—*Arctosa stigmosa* (Thorell), male and female from Norway (SMNH): 1. Female, dorsal view; 2. Epigynum, ventral view; 3. Male, dorsal view; 4. Male, left pedipalp, ventral view; 5. Left pedipalp, retrolateral view. Scale bar: 3.87 mm (Fig. 1); 0.25 mm (Fig. 2); 4.08 mm (Fig. 3); 0.72 mm (Figs. 4, 5).

Horaitz, Bălcauți (47°54'N 26°05'E), Calafindești (47°51'N 26°07'E) (Rosca 1935) (depository unknown; the study was carried out at the Zoological Institute of the University of Chernivtsi, Ukraine).

Material examined.—NORWAY: *Sør-Trøndelag*: 1 ♂, 1 ♀, Melhus, Gauldal (63°16'N, 10°16'E), 5 April 1994, K. Aakra (SMNH). GERMANY: *Bavaria*: 1 ♀, 1 juvenile, Isar River near Vorderris (river-km 241) (47°34'N, 11°25'E), 16 August 1994, R. Manderbach (WAM T56418); 1 ♀, same locality, 15 June 1995, R. Manderbach (WAM T56419); 1 ♂, same locality, 26 August 1994, R. Manderbach (WAM T56420); 1 ♂, same locality, 15 June 1995, R. Manderbach (WAM T56421); 1 ♂, Isar River near Vorderris (river-km 242) (47°34'N, 11°26'E), 2 September 1994, VWF (WAM T56422); 1 ♂, same locality, 20 May 1994, VWF (WAM T56423); 1 ♂, same locality, 13 June 1994, VWF (WAM T56424); 1 ♂, 1 juvenile same locality, 17 June 1994, VWF (WAM T56425); 1 ♂, Isar River near Schroefeln (47°33'N, 11°23'E), 1 August 1994, R. Manderbach (WAM T56426); 1 ♂, same locality, 31 August 1994, R. Manderbach (WAM T56427); 1 ♀, same locality 1 August 1994, R. Manderbach (WAM T56428); 1 ♂, same locality, 3 August 1994, R. Manderbach (WAM T56429); 1 ♂, 1 juvenile, same locality, 8 September 1994, R. Manderbach (WAM T56430). UKRAINE: *Lvivska Oblast*: 1 ♂, Dnister River, SE Sambir (49°28'N, 23°03'E), 21 September 1995, S. Niemeyer (WAM T66627); 1 ♂, same locality, 12 September 1995, S. Niemeyer (WAM T66628); 1 ♀, same locality, 5 August 1995, S. Niemeyer (WAM T62737); 1 ♂, same locality, 1 September 1995, S. Niemeyer (WAM T66629); 1 ♀, same locality, 4 August 1995, S. Niemeyer (WAM T66625).

Diagnosis.—Tegular apophysis of male pedipalp with one distinctly larger protrusion at retrolateral base and a few reduced protrusions on prolateral lobe (Figs. 11, 12). Median septum of epigynum straight, without round or hollow parts (Fig. 2). Maple-leaf-shaped median pattern on the carapace (Figs. 1, 3).

Description.—*Male (based on specimen from Gauldal, Norway):* Carapace dark brown, covered with slanted white setae; dark, radial pattern indistinct; median light band maple-leaf-shaped occupying over one half of carapace width and extending from behind

PLE to the end of dark median groove (Fig. 3); light spots present near lateral margins but almost fused to light median band. AER nearly straight in frontal view and slightly shorter than PMR; AME larger than ALE. QPE wider than long (ratio 100:148). Clypeus height similar to the diameter of AME. Chelicerae dark brown. Endites basally brown, apical part off-white with pale edge. Labium dark brown, re-bordered whitish. Sternum dark brown with lighter edge, sparse black, erect setae that are denser at margins. Legs light brown, with dark brown annulations except tarsi I–IV; coxae light brown dorsally and yellowish-brown ventrally. Leg formula 4123. Spination of leg I: femur: 3 dorsal (apical spine small), 1 apicoprolateral; tibia: 2 prolateral (sometimes 1 apicoprolateral), 2 ventral pairs; metatarsus: 1 prolateral, 2 ventral pairs and 3 apicoventral. Abdomen dorsally gray; yellow-brown lanceolate cardiac mark with irregular markings (Fig. 3); venter yellowish-brown without pattern. Spinnerets yellowish-brown. Pedipalp with two macrosetae at cymbium tip; terminal apophysis and embolus exposed ventrally; tegular apophysis prominent, sclerotized, transversely elongated and curved basally (Figs. 4, 5).

Female (based on specimen from Gauldal, Norway): Somatic characters and coloration similar to those of male (Fig. 1). Epigynum: median septum quadrangular, lateral edges almost parallel to each other; lateral edges of atrium depressed at the center (Fig. 2).

Measurements: male (female) (both based on specimens from SMNH): TL 6.56 (6.21), CL 3.42 (2.85), CW 2.49 (2.14). Eyes: AME 0.12 (0.11), ALE 0.09 (0.10), PME 0.25 (0.22), PLE 0.22 (0.17). Row of eyes: AE 0.62 (0.57), PME 0.67 (0.60), PLE 0.88 (0.84). Sternum (length/width) 1.27/1.48 (1.36/1.20). Labium (length/width) 0.43/0.40 (0.36/0.45). AL 3.42 (3.14), AW 2.35 (2.07). Pedipalp: Length of segments (femur + patella/tibia + tarsus = total length): 1.19 + 0.95 + 0.90 = 3.04 (1.19 + 1.09 + 0.76 = 3.04). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): I 2.28 + 2.85 + 1.90 + 1.19 = 8.22, II 2.18 + 2.47 + 1.71 + 1.04 = 7.40, III 1.99 + 2.04 + 1.66 + 1.04 = 6.73, IV 2.76 + 2.90 + 2.52 + 1.28 = 9.46 (I 1.85 + 2.23 + 1.42 + 0.95 = 6.45, II 1.66 + 2.09 + 1.38 + 0.95 = 6.08, III 1.71

+ 1.90 + 1.42 + 0.90 = 5.93, IV 2.38 + 2.76 + 2.28 + 1.19 = 8.61).

Distribution.—Central Europe (including Bulgaria, France, Germany, Norway, Romania, Switzerland, Ukraine) (Fuhn & Niculescu-Burlacu 1971; Heimer & Nentwig 1991; Aakra & Hauge 2000).

Habitat preferences.—Most common in gravel and sandy habitats in alluvial river floodplains (Framenau et al. 1996; Aakra 2000; Aakra & Hauge 2000); also reported from sandy, dry grasslands (Rosca 1935). Adults in March to July and October (Heimer & Nentwig 1991).

Arctosa subamylacea
(Bösenberg & Strand 1906)
Figs. 6–10, 13–17

Tarentula subamylacea Bösenberg & Strand 1906: 322, pl. 13, fig. 318.

Lycosa subamylacea (Bösenberg & Strand): Saito, 1959:55, figs. 36 a–b.

Arctosa cervina Schenkel 1936:191–194, fig. 63; Song 1982:75, figs. 1–2; Hu & Wu 1989:197, fig. 164.1–6; Chen & Zhang 1991:219, fig. 226.1–4; Zhao 1993:63, fig. 24a–c; Eskov & Marusik 1995:77, fig. 57; Marusik et al. 2000:80 (synonymy established in Paik 1994).

Avicosa cervina (Schenkel): Roewer 1955:234.

Hoggicosa subamylacea (Schenkel): Roewer 1955: 247.

Arctosa subamylacea (Bösenberg & Strand): Yaginuma 1960:85, fig. 76.6; Chikuni 1989:111, fig. 9; Tanaka 1991:308–311, figs. 29–32; Paik 1994: 41–44, figs. 9–19.

Arctosa kobayashii Yaginuma 1960: app. 6, plate 40, fig. 225, fig. 76.7; Yaginuma 1971:85, fig. 76.7 (synonymy established in Yaginuma 1986).

Arctosa stigmosa (Thorell): Zhang 1987:145–147, figs. 121.1–4; Song et al. 1999:319–320, figs. 190D, R; Namkung 2002:316, figs. 20.10a–b; Kim & Cho 2002:205, figs. 433–438 (not *A. stigmosa* sensu Thorell 1875a)

Type specimens.—*Tarentula subamylacea*: holotype female, JAPAN: *Saga Prefecture*: (ca. 33°14'N, 130°17'E): 1882, Dönitz (SMF 2198).

Arctosa cervina: holotype female, PEOPLES REPUBLIC OF CHINA: *South Kansu* (=Jansu): Tan-chang (ca. 36°05'N, 103°68'E), 28 September 1930, D. Hummel (SMNH).

Arctosa kobayashii: holotype female, JAPAN: *Tokushima Prefecture*: Tokushima-shi, Shikoku (34°03'N, 134°33'E), paddy field, 17 May 1957, Kobayashi (ASJ).

Material examined.—KOREA: *Kyonggi-*

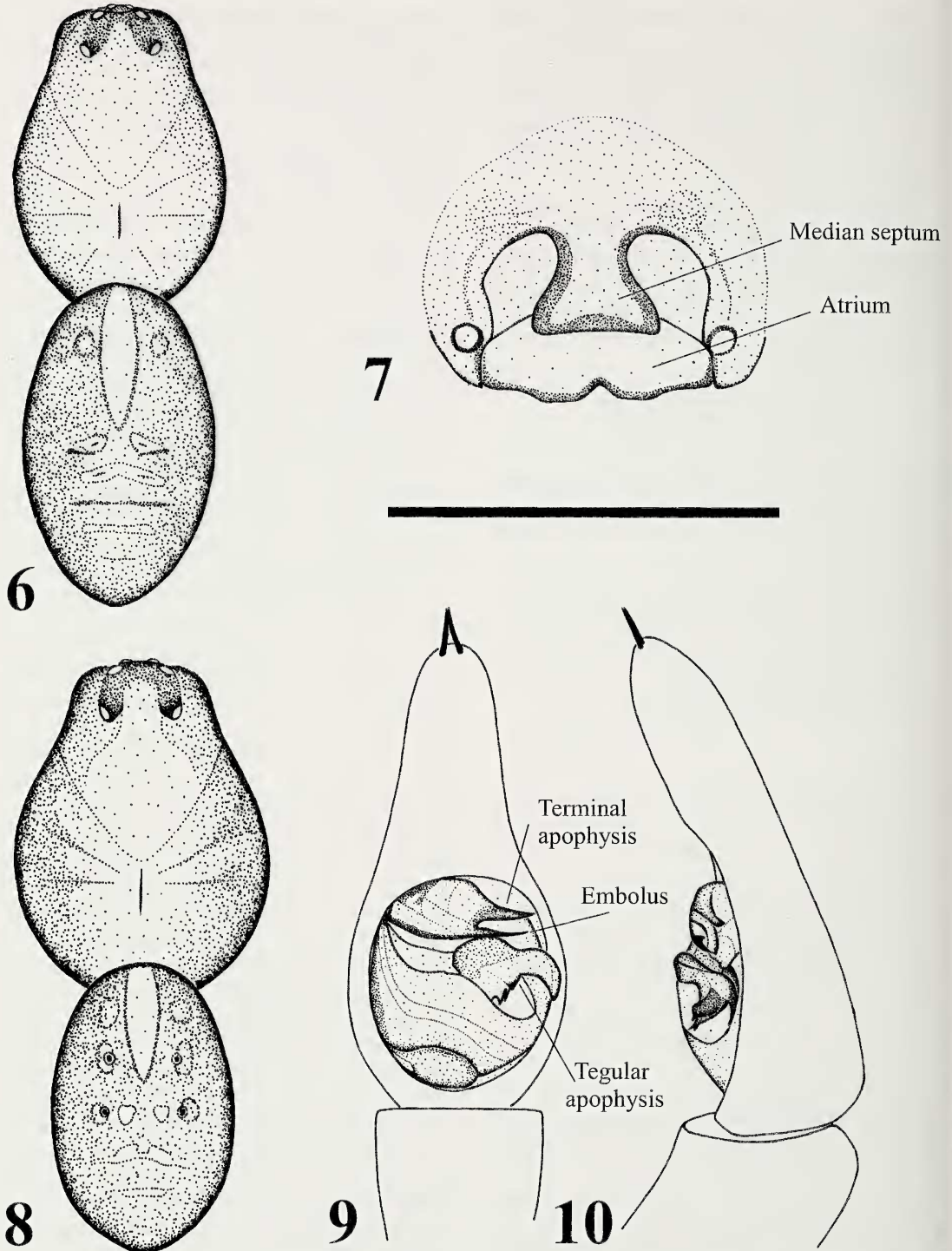
do: 1 ♀, Suwon-city (33°42'N, 126°26'E), 25 July 2003, JSY (WAM T62745); 1 ♀, same locality, 6 August 1999, JSY (WAM T62751); 1 ♂, Yeosu-gun, Ulkeuk-ri (37°25'N, 127°61'E), 25 November 1998, JSY (WAM T62754); 1 ♂, Yeoncheon-gun, Chungok-eup, Yeonderi (38°13'N, 126°91'E), 15 June 1999, JSY (WAM T62755); 2 ♀, same locality, 15 June 1999, JSY (WAM T62756). JAPAN: *Shigaken (Honshu)*: 2 ♂, 1 ♀, Otsu-city (35°00'N, 135°52'E), 9 June 1997, H. Tanaka (WAM T66632–4).

Diagnosis.—Tegular apophysis of male pedipalp with several small protrusions at the base, of which the middle one is generally the largest (Fig. 13, 14). Median septum of epigynum comparatively wider than that of *A. stigmosa* and widest posteriorly (Fig. 7).

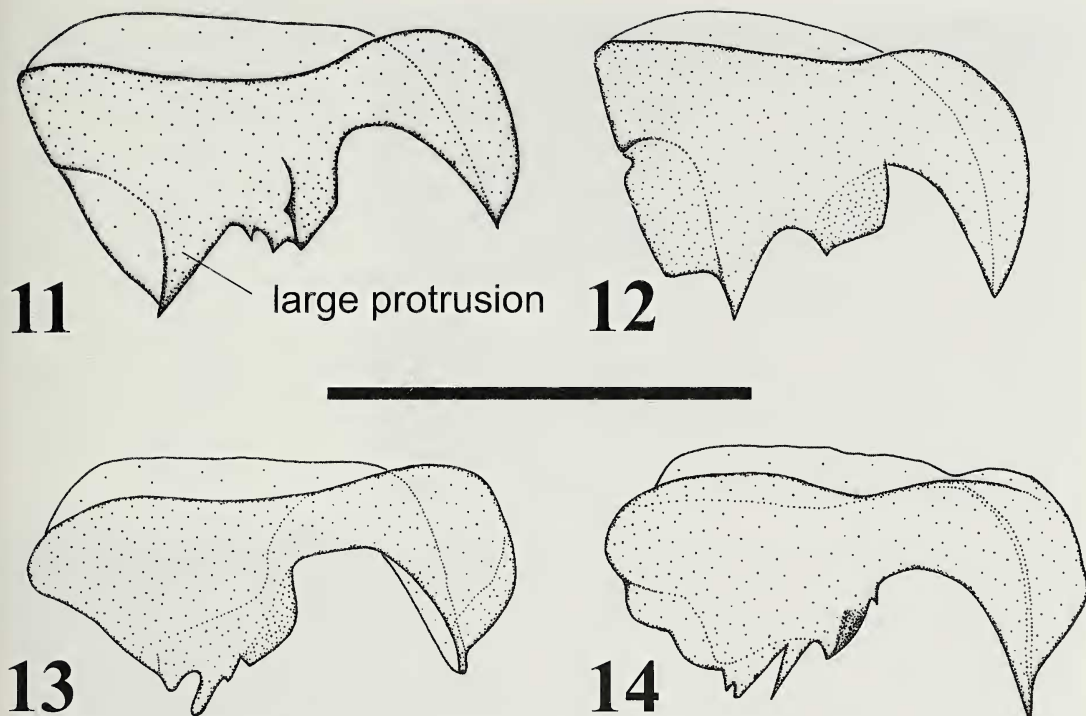
Description.—*Male* (from Otsu-city, Japan, WAM T66634): Carapace dark brown (Fig. 8), laterally covered with slanted short white setae; radial pattern indistinct gray; center of carapace lighter; submarginal bands dissolved into mottled vestiges, which almost fuse to the lighter median part. PME on a black, inverted U-shaped pattern. AER nearly straight in frontal view and slightly shorter than PMR; AME larger than ALE. QPE wider than long (ratio 100:148). Clypeus height equal to the diameter of AME. Chelicerae dark brown. Basal half of endites dark brown, apical half brown. Labium dark brown and palely rebordered. Sternum brown, sparsely covered with dark, erected and long setae that are denser near the margins. Legs dark brown, femora lighter, coxae brown; light annulations on femora, tibiae and metatarsi. Leg formula, 4123. Spination of leg I: femur: 3 dorsal (apical one small), 1 apicoprolateral; tibia: 2 dorsal, 2 ventral pairs; metatarsus: 2 ventral pairs and 3 apicoventral. Abdomen dark gray with a pale brown lanceolate cardiac mark which is surrounded by pale brown tiny spots; venter uniformly yellow. Spinnerets yellowish. Pedipalp with two macrosetae at cymbium tip; terminal apophysis and embolus sickle shape; tegular apophysis with one lobe with a few small protrusions.

Female (from Otsu-city, Japan, WAM T66632): Somatic characters and coloration are similar to those of male (Fig. 6). Epigynum: median septum widest at posterior end.

Measurements: male, WAM T66634 (female, WAM T66632): TL 6.92 (9.11), CL



Figures 6–10.—*Arctosa subamylacea*: (Bösenberg & Strand), males and females from Japan and Korea: 6. Female, dorsal view (WAM T66632); 7. Epigynum, ventral view (T62756); 8. Male, dorsal view (T66634); 9. Male, left pedipalp, ventral view (T62755); 10. Left pedipalp, retrolateral view (T62755). Scale bar: 5.52 mm (Fig. 6); 0.68 mm (Fig. 7); 4.57 mm (Fig. 8); 0.80 mm (Figs. 9, 10).



Figures 11–14.—Tegular apophyses of left male pedipalp in ventral view: 11, 12. *A. stigma* from 11. Ukraine (WAM T66628), 12. Norway (SMHN); 13, 14. *A. subamylacea* from 13. Korea (WAM T62754) and 14. Japan (WAM T66634). Scale bar: 6.82 mm.

3.99 (4.42), CW 3.07 (3.14). Eyes: AME 0.15 (0.16), ALE 0.11 (0.11), PME 0.27 (0.31), PLE 0.25 (0.28). Row of eyes: AE 0.62 (0.84), PME 0.64 (0.86), PLE 0.88 (1.17). Sternum (length/width) 1.46/1.77 (1.58/1.92). Labium (length/width) 0.57/0.52 (0.60/0.55). AL 3.42 (4.64), AW 2.57 (3.14). Pedipalp: Length of segments (femur + patella/tibia + tarsus = total length): 1.38 + 1.19 + 1.09 = 3.66 (1.61 + 1.60 + 1.14 = 4.35). Legs: Length of segments (femur + patella/tibia + metatarsus + tarsus = total length): I 2.61 + 3.04 + 2.09 + 1.19 = 8.93, II 2.38 + 2.85 + 1.95 + 1.09 = 8.27, III 2.28 + 2.42 + 1.90 + 1.14 = 7.74, IV 2.95 + 3.52 + 3.18 + 1.57 = 11.22 (I 2.76 + 3.33 + 1.99 + 1.33 = 9.41, II 2.47 + 3.04 + 1.90 + 1.33 = 8.74, III 2.42 + 2.71 + 2.33 + 1.19 = 8.70, IV 3.47 + 4.18 + 3.71 + 1.61 = 12.97).

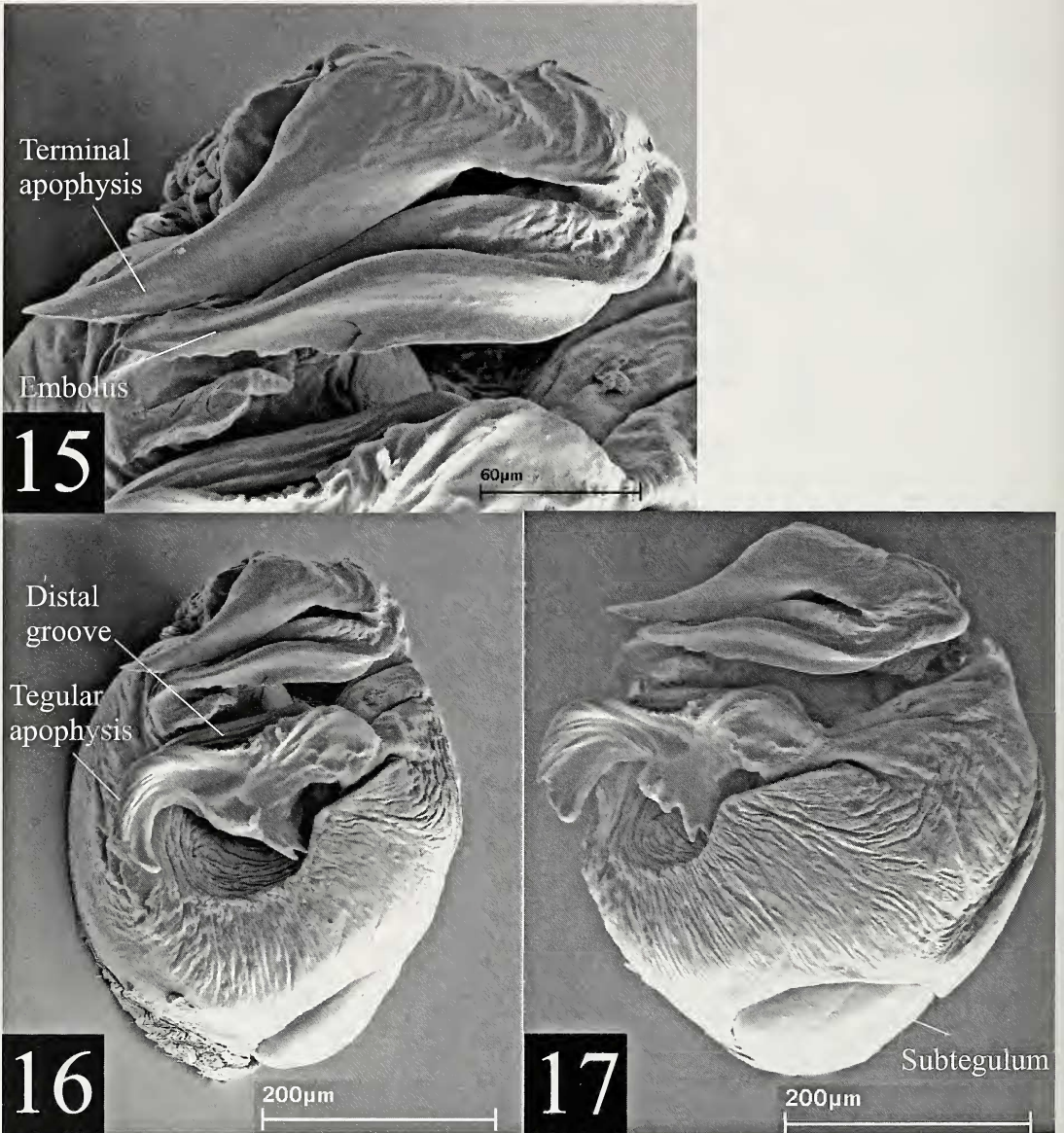
Distribution.—China, Japan, Kazakhstan, Korea (Paik 1994; Marusik et al. 2000)

Habitat preferences.—Common in habitats with low vegetation, such as meadows and grasslands. It is particularly common in agricultural areas such as near rice fields.

DISCUSSION

Arctosa stigma and *A. subamylacea* are very similar species and differences in the genitalia are very subtle. Similar to wolf spiders within the subfamily Lycosinae, males of both species have prominent and transverse tegular apophyses with a groove on the distal surface. The tip of the tegular apophysis is directed basally. The terminal apophysis is well developed and sickle-shaped (Figs. 4, 9). The embolus is transverse and not covered by the tegular apophysis in ventral view (Figs. 15–17). The epigynum has a conspicuous atrium divided by a median septum, but no distinct anterior hoods (Figs. 2, 7).

However, *A. stigma* and *A. subamylacea* are separated as distinct species by the following characters: (a) the basal edge of the tegular apophysis of the male pedipalp has one large, shark-tooth like protrusion at the base of the apophysis and a smaller lobe with small teeth retrolaterally from it in *A. stigma* (Figs. 11, 12), while in *A. subamylacea* the base appears as one lobe with a few small



Figures 15–17.—*Arctosa subamylacea* (Bösenberg & Strand) from Korea (NIAST): 15. Embolic division, ventral view; 16. Bulb of pedipalp, retrolateral view; 17. Bulb of pedipalp, ventral view.

separate protrusions (Figs. 13, 14); (b) the configuration of the median septum in female epigyna differs in the two species, although the variations may overlap. Overall, the posterior edge of median septum in all examined *A. subamylacea* is relatively wider than that of *A. stigmosa*; (c) the presence of maple-leaf-shaped median pattern on carapace in *A. stigmosa* (Figs. 1, 3), and (d) the lanceolate cardiac mark of *A. subamylacea* (Figs. 6, 8).

The habitat preferences of *A. stigmosa* and

A. subamylacea differ considerably although little is known of the ecology of these two species. *Arctosa stigmosa* is a riparian spider and appears to be confined to sand and gravelly riverbanks and is therefore closely associated with alluvial floodplains. It probably spends the day in litter close to the river banks (Dahl 1908; Framenau et al. 1996; Aakra 2000; Aakra & Hauge 2000). In contrast, *A. subamylacea* may be seen near ponds or lake-shores (Marusik et al. 2000), but it is com-

monly collected in agroecosystems and hilly environments in grassy vegetation (Paik 1994; JSY and KJP pers. obs.).

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LITERATURE CITED

- Aakra, K. 2000. Noteworthy records of spiders (Araneae) from central regions of Norway. *Norwegian Journal of Entomology* 47:153–162.
- Aakra K. & E. Hauge. 2000. Provisional list of rare and potentially threatened spiders (Arachnida: Aranea) in Norway including their proposed Red List status. *NINA Fagrapport* 42:1–38.
- Bösenberg, W. & E. Strand. 1906. Japanische Spinnen. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft* 30:93–422.
- Braun, R. 1963. Das *Tricca*-Problem (Arachn., Araneae). *Senckenbergiana Biologica* 44:73–82.
- Chen, Z.F. & Z.H. Zhang. 1991. *Fauna of Zhejiang: Araneida*. Zhejiang Science and Technology Publishing House, Hanzhu, Zhejiang, China. 356 pp.
- Chikuni, Y. 1989. *Pictorial Encyclopedia of Spiders in Japan*. Kaisei-sha Publishing Co., Tokyo. 310 pp.
- Chyzer, C. & W. Kulczyński. 1891. *Araneae Hungariae. Araneae Hungariae secundum collectiones a Leone Becker pro parte perscrutatas, conscriptae a Cornelio Chyzer a Ladislao Kulczyński*. Editio Academiae Scientiarum Hungaricae, Budapest. Volume 1:1–170.
- Dahl, F. 1908. Die Lycosiden oder Wolfsspinnen Deutschlands und ihre Stellung im Haushalt der Natur. Nach statistischen Untersuchungen dargestellt. *Nova Acta Academiae Caesaricae Leopoldino-Carolinae Germanicae Naturae Curiosorum* 88:175–678.
- Dondale, C.D. 1986. The subfamilies of wolf spiders (Araneae: Lycosidae). *Actas X Congreso Internacional de Aracnología, Jaca, España* 1:327–332.
- Dondale C.D. & J.H. Redner. 1983. Revision of the wolf spiders of the genus *Arctosa* C.L. Koch in North and Central America (Araneae: Lycosidae). *Journal of Arachnology* 11:1–30.
- Dondale, C.D. & J.H. Redner 1990. The Insects and Arachnida of Canada. Part 17. The Wolf Spiders, Nurseryweb Spiders, and Lynx Spiders of Canada and Alaska (Araneae: Lycosidae, Pisauridae, Oxyopidae). Agriculture Canada, Ottawa. Publication 1856. 383 pp.
- Eskov, K.Y. & Y.M. Marusik. 1995. On the spiders from Saur Mt. Range, eastern Kazakhstan (Arachnida: Araneae). *Beiträge zur Araneologie* 4:55–94.
- Framenau, V.W., M. Reich & H. Plachter. 1996. Zum Wanderverhalten und zur Nahrungsökologie von *Arctosa cinera* (Fabricius, 1777) in einer alpinen Wildflußlandschaft. *Verhandlungen der Gesellschaft für Ökologie* 26:369–376.
- Framenau V.W. & J.-S. Yoo. 2006. Systematics of the new Australian wolf spider genus *Tuberculosa* (Araneae, Lycosidae). *Invertebrate Systematics* 20:185–202.
- Fuhn, I.E. & F. Niculescu-Burlacu. 1971. Family Lycosidae. *Fauna Republicii Socialiste România, Arachnida* 5:1–253.
- Heimer, S. & W. Nentwig. 1991. *Spinnen Mitteleuropas: ein Bestimmungsbuch*. Paul Parey, Berlin. 543 pp.
- Hu, J.L. & W.G. Wu. 1989. *Spiders from Agricultural Regions of Xinjiang Uygur Autonomous Region, China*. Shandong University Publishing House, Jinan, China. 435 pp.
- Kim, J.-P. & J.H. Cho. 2002. *Spider: Natural Enemy and Resources*. Korea Research Institute of Bioscience and Biotechnology, Daejeon, Korea. 424 pp.
- Koch, L. 1881. Beschreibungen neuer von Herrn Dr Zimmermann bei Niesky in der Oberlausitz entdeckter Arachniden. *Abhandlungen der naturforschenden Gesellschaft Görlitz*: 17:41–71.
- Loksa, L. 1972. *Araneae II. Fauna Hungariae* 109: 1–112.
- Lugetti, G. & P. Tongiorgi. 1966. Su alcune specie dei generi *Arctosa* C.L. Koch e *Tricca* Simon (Araneae-Lycosidae). *Redia* 50:133–150.
- Marusik, Y.M., D.V. Logunov & S. Koponen. 2000. Spiders of Tuva, South Siberia. Institute for Biological Problems of the North, Magadan, Russia. 252 pp.
- Miller, F. 1971. Pavouci-Araneida. *Klíč zvířeny CSSR* 4:51–306.
- Moritz, M. 1992. Die Typen der Arachniden-Sammlung des Zoologischen Museums Berlin X. Araneae: Lycosidae. *Mitteilungen des Zoologischen Museums Berlin* 68:309–329.

- Murphy N.P., V.W. Framenau, S.C. Donnellan, M.S. Harvey, Y.C. Park & A.D. Austin. 2006. Phylogenetic reconstruction of the wolf spiders (Araneae: Lycosidae) using sequences from the 12S rRNA, 28S rRNA, and NADH1 genes: implications for classification, biogeography, and the evolution of web building behavior. *Molecular Phylogenetics and Evolution* 38:583–602.
- Namkung, J. 2002. The Spiders of Korea. Kyo-Hak Publishing Co., Seoul. 648 pp.
- Oligier, T.I., Y.M. Marusik & S. Koponen. 2002. New and interesting records of spiders (Araneae) from the Maritime Province of Russia. *Acta Arachnologica* 51:93–98.
- Paik, K.Y. 1994. Korean spiders of the genus *Arctosa* C. L. Koch, 1848 (Araneae: Lycosidae). *Korean Arachnology* 10:37–65.
- Park, Y.C., J.-S. Yoo, M.P. Schwarz, N.P. Murphy & J.-P. Kim. 2007. Molecular phylogeny of East Asian wolf spiders (Araneae: Lycosidae) inferred from mitochondrial 12S ribosomal DNA. *Annals of the Entomological Society of America* 100: 1–8.
- Platnick, N.I. 2007. The World Spider Catalog, Version 7.5 American Museum of Natural History, New York. Online at <http://research.amnh.org/entomology/spiders/catalog/INTRO1.html>
- Rack, G. 1961 Die Entomologischen Sammlungen des Zoologischen Staatsinstituts und Zoologischen Museums Hamburg. II. Teil Chelicerata II: Araneae. *Mitteilungen des Hamburgischen Zoologischen Museums und Instituts* 59:1–60.
- Roewer, C.F. 1955 [imprint date 1954]. *Katalog der Araneae von 1758 bis 1940. Band 2.* Institut Royal des Sciences Naturelles de Belgique, Bruxelles. 1751 pp.
- Rosca, A. [Roschka, A. in original] 1935. Neue Spinnenarten aus der Bukowina (Rumänien). *Zoologischer Anzeiger* 111:241–254.
- Saito, S. 1959. *The Spider Book Illustrated in Colours.* Hokuryukan, Tokyo. 194 pp.
- Schenkel, E. 1936. Schwedisch-chinesische wissenschaftliche Expedition nach den nordwestlichen Provinzen Chinas, unter Leitung von Dr. Sven Hedin und Prof. Sü Ping-Chang. Araneae gesammelt vom schwedischen Arzt der Expedition Dr. David Hummel 1927–1930. *Arkiv för Zoologi* 29:1–314.
- Simon, E. 1876. *Les Arachnides de France, Volume 3:1–364.* Encyclopédie Roret, Paris.
- Simon, E. 1937. *Les Arachnides de France, vol. 6: Synopsis Générale et Catalogue des Espèces Françaises de l'Ordre des Araneae; 5^e et dernière partie, Pp. 979–1298.* Encyclopédie Roret, Paris.
- Song, D.X. 1982. Studies on some wolf spiders from China. *Sinozoologia* 2:75–80.
- Song, D.X., M. Zhu & J. Chen. 1999. *The Spiders of China.* Hebei Science and Technology Publishing House, Shijiazhuang, China. 640 pp.
- Tanaka, H. 1991. Lycosid spiders of Japan VII. The Genus *Arctosa* C.L. Koch. *Sonoda Women's College Studies* 25:289–316.
- Thorell, T. 1875a. *Verzeichnis südrussischer Spinnen.* *Horae Societatis Entomologicae Rossicae* 11:39–122.
- Thorell, T. 1875b. Descriptions of several European and North African spiders. *Kongliga Svenska Vetenskaps-Akademiens Handlingar (N. F.)* 13: 1–203.
- Vink, C.J., A.D. Mitchell & A.M. Paterson. 2002. A preliminary molecular analysis of phylogenetic relationships of Australasian wolf spider genera (Araneae, Lycosidae). *Journal of Arachnology* 30:227–237.
- Yaginuma, T. 1960. *Spiders of Japan in Colour.* Hoikusha, Osaka. 186 pp.
- Yaginuma, T. 1971. *Spiders of Japan in Colour. Enlarged and revised edition.* Hoikusha, Osaka. 197 pp.
- Yaginuma, T. 1986. *Spiders of Japan in Colour. New edition.* Hoikusha, Osaka. 206 pp.
- Zehethofer, K. & C. Sturmbauer. 1998. Phylogenetic relationships of Central European wolf spiders (Araneae: Lycosidae) inferred from 12S ribosomal DNA sequences. *Molecular Phylogenetics and Evolution* 10:391–398.
- Zhang, W.S. (ed.) 1987. *Farm Spiders from Hubei Province.* Hubei Science and Technology Press, Shijiazhuang, China. 299 pp.
- Zhao, J.Z. 1993. *Spiders in the Cotton Fields in China.* Wuhan Publishing House, Wuhan, China. 552 pp.

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